THE GLASS INDUSTRY

VOLUME 23, NUMBER 5, MAY, 1942

ANNUAL MEETING OF THE CERAMIC SOCIETY

Glass Division meetings are well attended as an unusually large number of papers are presented in three half-day sessions.

The technical sessions of the Glass Division at the 44th annual meeting of the American Ceramic Society were characterized by an unusually large number of papers to be presented in three half-days. The skillful handling of time by Chairman A. K. Lyle, together with the appeal made by Program Chairman W. C. Taylor, who succeeded in preparing the authors so that their papers could be handled with a minimum of verbiage, resulted in expeditious covering of ground.

As styles change in other fields of human interest, so do the prevailing modes in the scientific approach to the problems of Glass Technology. At the present time, the tendency in all explanations of behavior is toward reference to fine structure. The silicon-oxygen network, which has been made so real for us by the X-ray technologists, seems to need no further bolstering as a sound theory of the structure—or lack of structure, as one prefers—of the glasses. It serves most conveniently as a many-pronged rack upon which to hang many additional notions and explanations of the vagaries of our favorite material.

Although his paper made no reference to hypothetical linkage of atoms, Dr. Arthur Q. Tool presented what was probably the most advanced scientific treatment of his subject offered by any of the authors. With the invention of what he called a "fictive" temperature, Dr. Tool offered a reasonable explanation of the strange phenomena in a field in which he has long been one of the principal investigators. This is the study of the changing properties of glass in the annealing range, or region in which the glass is neither quite solid nor quite fluid. Much reading of this paper will be necessary for most of us before we arrive at any clear understanding of the new idea and the mathematical treatment of it. It can be immediately seen, however, that here is a neat explanation of certain facts that have hitherto been dismissed with the explanation "depending upon thermal history." The exceedingly slow way in which the glass, as it approaches rigidity upon cooling, attains genuine equilibrium for a given temperature, brings great emphasis upon the word *history*. We are compelled to like the use of the term "molecular readjustments," which involves no concepts that cannot be demonstrated and which suggests nothing about constitution, dissociation, chemical combination, ionization, opening or closing of cavities in the network, nor any other still more vague interpretations.

J. B. Saunders, of the National Bureau of Standards, brought a method which should give aid and comfort to those who have sat for endless hours watching the interference fringes move as they studied expansion by means of the interferometer. It is altogether possible, however, that although the Division enjoyed priority so far as the public presentation of the method is concerned, its members may not be so fortunate in getting the actual equipment in these times.

It might be said in the way of mild criticism that certain papers were presented whose application to practical glass-making seems very remote, if not altogether lacking. On the other hand, we never know when these scraps of genuine scientific information may become of value, even though the experimental work upon which the results are based has been performed on glasses of compositions that can never see the light in a useful piece of ware. In this category must be placed dissertations such as that of Dr. Kuan-Han Sun, Nelson W. Taylor and Hurd W. Safford on the "Properties of Soda-Silica Glasses at High Temperatures"; "The Structure of Sodium Borate Glass as Affected by Temperature," by A. E. Badger and H. C. Johnson; and "The Parachor of Inorganic Liquids at High Temperature," by Kuan-Han Sun and Alexander Silverman. Such papers, difficult as they may be to follow for the average listener, serve to demonstrate that the study of glass has become intensive in the extreme. The major problems of composition and the like are fairly well in hand, and the University people are giving glass a going-over that would not have seemed possible a decade ago.

Now that the chemists at Corning Glass Works have brought out that amazing product known as "Vycor," the stuff is turned over to the tender mercies of the physicists, and the reports begin to come in. Dr. Howard R. Lillie reported upon the expansion characteristics of Corning 96 per cent silica glass No. 790, giving a reasonable explanation of the fact that it apparently allows fused silica to overtake it in expansibility at higher temperatures. Here again the idea of fine structure is called upon as a basis for explanation.

W. W. Grigorieff and C. M. Lampman, Jr., of the General Electric Company, gave an interesting description of their work on Sealed Glass Bushings, and were kind enough to bring with them specimen products neatly sawed in half so that all could see the extent of their success in solving the important problem of joining glass and metals.

Any salesman who has demonstrated the excellence of his goblets by striking them with a lead pencil until they ring, or anyone who has exercised his musical talent by stroking the rim of a tumbler with a wet finger, would have been interested in the paper by Joe G. McCann, "Investigation of Decay of Vibration Phenomena of Glass Bars." The idea was to determine what makes glass

ring and keep on ringing. The author seemed to imply that the answer was lead, but there are many who will insist that potash must have had some part in the sonorousness.

Welcome variety in the program was supplied by a paper by L. S. Longenecker of Frazier-Simplex, Inc.: "Is a Tank Crown Only a Roof Inclosure?" He presented several criticisms of the arched roof, now the standard cover of glass tanks, and while some of these criticisms might themselves be criticized as being somewhat overdrawn, the author at least presented food for thought, if only along the general idea that the methods of usage and custom are not always the best. His idea for suspended flat crowns, adjustably placed to give controlled flame conditions and heat distribution, were highly original and interesting. Although direct experience with this type of construction on glass tanks is still rare, it has found useful application in the field of steel manufacturing.

Continuing the series of papers by means of which they have brought together many useful data on the "Soda-Dolomite Lime-Silica Glasses," the members of the staff of the General Research Laboratory of Owens-Illinois Glass Company have shown the effect of iron oxide on such glasses. Although the undoubted greenness of glass containing iron in the specified quantities might make them unusual, to say the least, in any commercial articles other than goggles, the work must be regarded as a real contribution, since it brings us closer to an understanding of what can be done to alter the properties of glasses, as we over-simplify them in our common way of thinking about them.

The work of F. M. Veazie and W. A. Weyl, who showed than tin in Gold Ruby glass and other glasses which depend for their color on the separation of colloidal particles of a metallic element, has nothing to do with oxygen exchange, but specifically influences the solubility of these metals and the way in which colloidal particles of them separate as the glass is first cooled and then "struck." Also from the laboratory of Penn. State College, Edward Forst, Jr., and Norbert J. Kreidl showed that silver can do something more than produce a muddy yellow color, and that it is capable of making a red glass if some halide (for example silver chloride) is present.

Because of the present spread of fluorescent lighting and the rapid development of the subject, both industrially and scientifically, a paper on "Photoluminescence in Glasses" was most timely. This was prepared by A. R. Rodriguez and C. W. Parmelee, University of Illinois, who applied the spectroscope in the study of uranium and copper ruby glasses, thereby delving into the nature of this little-understood phenomenon. "Diffusion in Glass," which has been observed heretofore, and which is still not thoroughly investigated, was presented by J. A. Pask and C. W. Parmelee, who applied numerous chemical compounds to glass surfaces and observed rate and character of migrations.

"Wet Chemistry Versus Dry Chemistry" formed the theme of the study by Alexander W. Silverman and Hurd W. Safford on precipitates versus fired colors. These workers prepared ceramic colors by precipitation from water solutions, getting some unusual results, which seemed to depend upon which solution was poured into which, but in general succeeding in getting equally good colors for use in glass melts and in decorations.

At the luncheon on Wednesday noon the officers for the coming year, who had already been elected by ballot, were announced as follows: Chairman, W. C. Taylor, Corning Glass Works; Vice-Chairman, J. F. Green, Kimble Glass Company; and Secretary, S. R. Scholes, Alfred University.

The Chairman expressed the regret of the division at the inability of Professor Parmelee to accept nomination for office on account of ill health. For several years, it had been the custom of the division to elect a second Vice-Chairman, who was later automatically promoted to become Vice-Chairman, and finally Chairman of the division. Professor Parmelee was second Vice-Chairman during the past year. The point was raised that this office had actually become unnecessary, and upon motion, steps were taken to revise the rules so that this office should be abolished. In connection with the Fall Meeting the point was made that it will be well to avoid conflict with meetings of other societies, and in particular the American Chemical Society. The Publications Committee of our division was commended for its excellent work during the past year, during which period 40 per cent of the papers published by the American Ceramic Society were on glass.

A message prepared by R. M. Curts was sent by the division to Mr. A. N. Finn, who was prevented by serious illness from attending this meeting. Mr. G. E. Barton, the Dean of American Glass Technologists, recently honored by the American Chemical Society upon the completion of fifty years of membership, was called up for a round of applause.

The attendance at the Glass Division sessions ran close to one hundred, and nearly 80 members participated in the business luncheon. Dr. J. T. Littleton's presidential address to the American Ceramic Society follows:

"While I think it would be fitting on this occasion to discuss the progress of our Ceramic Arts and Sciences, I believe it to be more appropriate at this time to summarize in a general way the broad functions of this Society. We are at war, we will remain at war for some time. Then there will come a peace. Just what are the relationships of this body to this war and to the peace?

"Let us not consider ourselves as the American Ceramic Society only but as an American Scientific and Engineering unit. We are one member of such groups, one society among others. Our work has not only been national but international in its scope. We the engineering and scientific societies of this world, have directed and controlled the progress of civilization. We are international. There has been and never will be such a thing as scientific isolation. It can only exist as scientific stagnation. The only freedom we have ever had is a freedom of thought and our scientific societies are the medium for the exchange of this freedom and our publications are our points of contact with the rest of the world.

"Our own arts bear witness to the fact that progress has been international, each nation dependent upon the others for its progress. The German scientist depended upon Bert Maxwell, an Englishman, for the development of the electromagnet theory of light, the Englishman in turn waited for Max Plank for the mathematics of radia-

W. C. Taylor

tion theory. In ceramics we find Turner in England, Gehlhoff in Germany mutually dependent for their progress in glass technology. The microscope used in America was the development product of Abbe and Faraday. The American soldier in the Philippines uses the tetanus vaccine developed from the discoveries of the Japanese, Kitasato, and the Japanese soldier has his life restored to him on the operating table while under the anesthesia developed by American laboratories and first used by American surgeons. In Italy and in Austria and Japan they melt glass in tanks made from Corhart blocks. Tamman and Zschimmer have pointed the thought of Americans, Englishmen and Frenchmen to the fundamentals of ceramic science. The Bureau of Standards and the Geophysical Laboratory have exchanged their information with the Reichsanstalt. Mme. Curie and the isolation of radium comes from Paris and Marconi came from Italy. Pasteur, Lister and Koch together bring us the possibilities of modern surgery. Civilization has advanced only on account of international scientific cooperation. We all of us are benefited by such contributions.

"The American Ceramic Society is the American agency and medium for national and international cooperation in ceramics. Through its publications, its meetings and its abstracts it keeps us in constant touch with our associates the world over. There is no national boundary to science and there is no national limitation to progress in ceramics. The only isolationist is the one who draws into his own shell and excludes the contacts with others that our meetings and publications give him.

"But now we are at war. Temporarily, at least, our structures of international cooperation have broken down. Instead we have substituted international destruction. Our societies are now only national units. We are in conflict with similar organized units in our enemy countries. We are fighting not alone to win this war but so that we may have a place in the peace to come. Need I urge any further for the united support of a membership? A time is coming very shortly when the industries we represent will need much more than we can give them. There will be the period of readjustment following the war. We must prepare for this now. Our Society and its activities are far more essential to our industries now than they have ever been before. I do not know whether you realize it or not but the ceramic industry, as gauged by the relative volume of its exports, is the most important peace time industry of our enemies. But lest you do not see the seriousness of our battle, I am going for a moment to statistics.

"The relative export business of these countries is shown by the following data for the year 1937.

WORLD TRADE IN GLASS AND CERAMICS, 1937

Per Cent of Exports by Country

Germany	41.11
Czechoslovakia	17.29
United Kingdom	13.91
Japan	11.94
United States	9.20
France	4.57
Italy	1.51

"I believe the Ceramic Industry is more vitally affected by the outcome of this War than is any other of our major industries. The organization and people who in 1937 controlled the export business of the World will be back and the conditions they will face will force them to produce and try to market a very cheap but probably high grade of product. We all have great respect for the research ability and ingenuity of Germany and Central Europe. Their ceramic laboratories and institutions have certainly been developed to such a state that we cannot afford to minimize their importance or their potentiality. Their competition will be very serious. This condition can be best faced by a more concerted and united effort on our part. As individuals of our industries we must be sure that we are neglecting nothing. Our Society through its meetings and its publications brings us together, gives us the opportunity to develop and test our productive ideas. We are united for the purpose of mutual development. We are going to need this united effort more than we have ever needed it before and by we, I mean the industries we represent."

Properties of Soda-Silica Glasses at High Temperatures.
By Kuan-Han Sun, Nelson W. Taylor, and Hurd W. Safford.

1. *Expansion.* By use of the best available data for the specific volumes of soda-silica glasses in the temperature range 900-1400° C, equations were derived giving the coefficients of expansion for the compositions 40-50% SiO_2, and 50-80% SiO_2, respectively. These may be written $\delta \times 10^9 = 147200 - 2062p$, and $\delta \times 10^9 = 76100 - 639p$, where p is the percent silica. It will be seen that in the low silica glasses, small additions of SiO_2 are roughly three times as effective in reducing the coefficient of expansion as in glasses of higher silica content. It was shown that the reason for this is that silica is a network former and the character of the melt is changing rapidly in the low silica range and not so rapidly in the high silica range, when small additions of silica are made.

2. *Density, and specific volume.*

Specific volume of glasses at an arbitrarily chosen temperature (1400° C) were first correlated with composition, and equations were combined with those for coefficient of expansion. These are

(1) For 40-50% SiO_2;
$v = 0.2965 + 1.47 \times 10^{-4} t + (1984 - 2.06\ t)\ 10^{-6}\ p.$

(2) For 50-80% SiO_2;
$v = 0.3623 + 0.761 \times 10^{-4} t + (667 - 0.637\ t)\ 10^{-6}\ p.$

where v = specific volume, t = temp. ° C, p = percent SiO_2.

It is well known that the specific volume, i.e., the volume per gram, of soda-silica glasses is increased at room temperature by increasing the percentage of silica. This is primarily because sodium ions occupy "holes" in a Si-O network. If they are removed, i.e., if the glass is made more siliceous, the density is reduced and the specific volume is increased. On the other hand, at high temperatures, the increase in percent silica causes a decrease of specific volume, i.e., a higher density. This contrast arises from the fact that high soda glasses have a higher coefficient of thermal expansion than high silica glasses, due to the weaker bonds produced by the singly charged sodium ions. Therefore, when the temperature is high the addition of silica contracts or draws together the whole network structure, leading to a higher density.

3. *Surface tension, parachor, and viscosity.*

Calculations relating to these properties have also been made and certain conclusions drawn from them as to the character of the various glasses. Further details will be presented in the published paper. Some comments will also be made concerning the factors controlling the rate of crystallization.

Expansion Characteristics of Corning 96 Per Cent Silica Glass No. 790. *By H. R. Lillie, Corning Glass Works.*

It has been reported in the literature that the expansion curve of Vycor Brand glass No. 790 is above that of SiO_2 glass up to a temperature of about 650° C., at which point it crosses the latter and falls considerably below it at 850° C. Data obtained by the author, using an interferometer, failed to confirm this finding but yielded a curve that stayed well above that of SiO_2 glass up to 935° C. Since the effect of minor constituents upon the expansion characteristics of ordinary glasses is usually qualitatively independent of temperature, particularly when the addition both softens the glass and raises its expansion, it was believed that the results obtained in this present study are more nearly in line with what might be expected.

Apparatus for Recording the Movement of Interference Fringes. *By J. B. Sanders, National Bureau of Standards.*

When making thermal expansion measurements by the use of the interferometer method the operator must observe and count the movement of the fringes. As such observations may run over a period of a few hours to several days some investigators have used a photographic method for recording the moving interference fringes. In the usual method about twenty pictures are necessary to record the passage of each fringe, thus a very long strip of film is required to record a test if the expansion is large. Such pictures, moreover, seldom show a fringe at the exact time when it is passing the fiduciary point in the field.

In an effort to eliminate these defects in the photographic method a new photographic method has been developed. In this new method a continuous record of the fringe movements is produced and requires only about 1 per cent of the film needed by the old method. In addition the instrument is so designed that it is possible to view the fringes at any time without stopping the recording of their movement. By this new method it is possible to readjust the alignment of the furnace and accessory viewing instruments at any time without stopping the recording of the data.

An Analytical Representation Concerning Glass in Its Glass Annealing Range. *By Arthur Q. Tool, National Bureau of Standards.*

The nature of Dr. Tool's paper is such that it is not easily condensed, however the original abstract covers the subject quite completely and is therefore reproduced below:

Whenever simple, highly fluid liquids are being heated or cooled, they ordinarily assume almost immediately, on reaching any temperature, conditions that are uniquely determined by that temperature, and the condition of any such liquid remains unchanged if no further temperature change occurs. As far as any ordinary test will show, it seems, therefore, that all molecular readjustments that are necessary in the liquid to bring it to a condition compatible with the temperature it may have attained are fully developed just as soon as the temperature is reached without regard to the rate of temperature change; that is, whenever such a liquid is heated or cooled, it always follows closely a definite equilibrium curve.

This seemingly instantaneous response of all molecular readjustments to a temperature change does not occur in highly viscous liquids. These more sluggish readjustments, as a result, may be delayed until the temperature change is completed if the rate of that change is sufficiently high. It may be necessary after any temperature change, in fact, to hold such a liquid for a considerable time or even indefinitely at a constant temperature before its condition becomes stabilized at that temperature. By stabilizing these liquids at a number of temperatures, however, definite equilibrium curves may also be established for many of them.

A study of the changing properties of any one of these liquids while it is being stabilized at any temperature will show that the condition of the liquid at any instant closely approximates a condition that would be stable at some other temperature. For example, if the liquid were brought to this temperature very quickly, it would be on its equilibrium curve. A temperature which thus represents the instantaneous molecular condition of a liquid that is at some other actual temperature, T, may be considered as the fictive temperature, τ, of the liquid at that instant, and this fictive temperature, as time progresses, continually approaches the actual temperature of the liquid as the end point.

It will also be found that the time rate at which τ approaches the constant actual temperature, T, is expressed approximately in terms of $(T-\tau)$, the potential change in τ by the relation,

$$d\tau/dt = K'(T-\tau),$$

in which K' is the reciprocal of a relaxation time and a function of both T and τ as are all other properties or coefficients of the liquid. To simplify matters, the dependence of K' on τ will be ignored for the present. Its dependence on T in many cases is expressed approximately by the relation,

$$K' = Ke^{T/k},$$

in which K and k are presumably constant for a particular liquid. Introducing this assumed equivalent of K' into the foregoing relation for $d\tau/dT$ yields an expression which holds presumably even when T is changing. If T is changing at any rate, $R = dT/dt$, the temperature rate of the change in τ at any temperature is given by the relation,

$$d\tau/dT = (K/R)(T-\tau)e^{T/k}.$$

If R is constant and the substitution,

$$x = \pm (Kk/R)e^{T/k}$$

(the double sign makes x positive even when R is a cooling rate) is used, the solutions of this differential equation are

$$(T-\tau)_h = ke^{-x}(Ei(x) - Ei(x_h')) \quad \text{(for heating)}$$

and

$$(T-\tau)_c = ke^{x}(Ei(-x) - Ei(-x_c')) \quad \text{(for cooling)}.$$

In these relations, x_h' *and* x_c' are the values for x when $(T-\tau)=0$.

By using tables of the exponential integrals, $Ei(x)$ and $Ei(-x)$, values of τ for all temperatures, T, are computed easily for any heating or cooling, provided K, k, R, and one value of τ (such as τ_0 at T_0) are known. If, moreover, the expansivities, a and a', are known (a being the coefficient for expansion that occurs when τ is constant and T varies and a' being the coefficient for the expansion when T is constant and τ varies), it is possible to compute expansion curves for any rate of heating or cooling. If corresponding specific heats, s and s', similarly are known, it is possible to obtain heating and cooling curves which show extraordinary endothermic and exothermic effects in certain temperature ranges.

If the coefficients employed throughout the computations approximate those of ordinary glasses, the similarity between computed and experimental curves is striking. The chief discrepancies between these curves appear to be the result of the assumption that K' is independent of τ. Despite all discrepancies arising from simplifying assumptions, the great similarity between the two sets of curves makes it appear that the behavior of an ordinary glass in its annealing range differs very little from the behavior of an extremely viscous liquid. That is, much of the molecular readjustment in an ordinary glass when it is being annealed or disannealed is, in its nature, not materially unlike the molecular readjustment that occurs in many highly fluid liquids when they are being cooled or heated; in a highly viscous liquid or glass, however, this readjustment is so greatly retarded by the high viscosity that, before it develops, the materials may be cooled to low temperatures where it is delayed indefinitely.

An Investigation of the Decay of Vibration Phenomena of Glass Bars. *By Joe G. McCann, Engineering Experimental Station, Ohio State University.*

In evaluating the quality of glassware such as goblets the customary procedure is to observe the "ring" produced

GLASSMEN AT WORK AND PLAY AT A.C.S. CONVENTION

1. Fred W. Dixon, Jr., introduces his bride to her first A.C.S. Convention. Carl Hertzig and C. B. Delgado attend.

2. Doctors Littleton and Adams ponder a difficult problem during the Glass Division Luncheon.

3. Glassmen display keen interest in the proceedings at a Division Meeting. In the background Armand Houze and Vic Remington take it standing up.

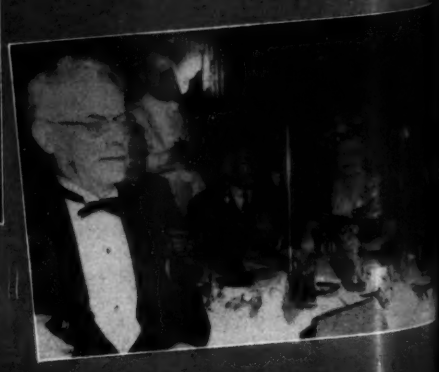
4. Louis Navias and fellow glassmen relax between sessions in the editorial rooms.

5. E. L. Hettinger gets on the far side of the camera lens with Carl Henssner of Chrysler.

6. Dr. and Mrs. A. Q. Tool enjoy the party.

7. Camera Club dinner. Even if we hadn't caught Earl Frazier in the picture we'd have known he was there.

8. Louis Bryant Tuckerman, Edward Orton, Jr., Fellow Memorial Lecturer for 1942.



9. At the All-Out-For-Fun Party Dr. Silverman applauds one of the acts. Hettinger doesn't seem surprised, can't tell what Mrs. J. Earl Frazier thinks about it.

10. E. L. Hettinger—an amateur or veteran photographer.

11. Dr. J. C. Hostetter and Virgil Mulholland attend the Camera Club Dinner.

12. Hostetter and Sharp tarry after a Glass Division Session to be taken.

13. Glassmen Division Luncheon with all members devoting to the menu.

14. Dr. Alexander Silverman, Dept. of Chemistry, University of Pittsburgh.

15. Messrs. Walworth and Wampler of Libby-Owens-Ford.

16. Good joke? Anyhow Fred Dixon, Erwin F. Zeiller, Bob Galbraith and O. T. Fraser seemed to enjoy it.

17. Hopi Indians broadcast for the Ceramic Society.

18. Another table at the Luncheon.

when the goblet is struck. If the "ring" is sustained, i.e., the vibrations continue for some time the glass is of good quality but if the "ring" is dead, i.e., the vibrations die away rapidly, the glass is of inferior quality. In the present investigation a method of making a quantitative measurement of the "ring," i.e., the degree to which the vibrations are sustained was developed and applied to the study of the effects of chemical composition, shape and degree of annealing on the "ring."

Glasses of four different chemical compositions were made and cast with bars, which were either annealed or disannealed. The bars were then struck, the "ring" picked up by a microphone and amplified and impressed on an oscillograph. The vibrations were photographed by the means of a camera focused on the oscillograph screen.

From the data obtained it was concluded that the modulus of decay is directly proportional to the length for bars of the same cross-section and chemical composition. In other words, the tone quality of a goblet of any composition may be improved by altering its design. As the lead content of the glass increased the tonal quality increases. Disannealing results in a lowering of the pitch of the "ring" and impairs the tone quality.

Sealed Glass Bushings. *By W. W. Grigorieff and C. M. Lampman Jr., Pittsfield Works Laboratory, General Electric Company.*

Hermetically sealed insulating bushings are used in liquid or gas filled electrical apparatus which are operated under pressure, their function being to carry a lead from the interior of the apparatus to some point outside the shell where contact can be made. Such insulators must be adequate insulators, pressure tight, strong, resistant to the weather, thermal shock resistant and easily fastened to other apparatus by welding or soldering. To meet these properties a glass bushing with sealed-in metal inserts was found to be the best solution. However the glass and metal inserts must have comparable thermal expansion coefficient curves so as to give a matched glass to metal seal.

Various glass to metal combinations were shown and the expansion properties of both the metals and glasses were given. In brief the method of manufacture consisted of melting the special composition glass electrolytically, casting into preheated molds of graphite or iron which have the special metal inserts in place, annealing from 500° C. to 350° C., and cutting off the stub end of the bushing. The finished bushings are then fastened to the apparatus by welding or soldering thus eliminating the use of cork gaskets.

Special tests such as weathering, thermal shock resistance, mechanical strength and electric characteristics which have been applied to these sealed glass bushings were also described.

Structure of Sodium Borate Glass as Affected by Temperature. *By A. E. Badger and H. C. Johnson, Department of Ceramic Engineering, University of Illinois.*

A series of sodium borate glasses containing 0 to 30% Na_2O and 0.1% of cobaltoxide as a coloring agent was prepared by melting in platinum and then casting in the form of disks. Spectrol transmission measurements were then made throughout the range of room temperature to the softening temperature of the glasses by the means of a General Electric automatic recording photoelectric spectrophodometer and a specially designed furnace assembly.

The change in color of the chromophore was correlated with the structure of the glasses as previously deduced by Biscoe and Warren. Measurements made at the higher temperatures indicated that abrupt changes in spectrol transmission occurred near the transformation temperature of the various glasses. The transmission curves of the glasses at room temperature showed variations at about 15% Na_2O which were correlated with the known breaks in the physical properties of these glasses which occur near this composition. Theoretical deductions indicated that stable configurations in the glasses should exist near compositions containing 10% and 20% Na_2O.

The use of color indicators to note structure changes appears to be a reliable method for studying the structure of glass at high temperatures.

Effect of Iron Oxide on Properties of Soda-Dolomite Lime—Silica Glasses. *By Owens-Illinois Glass Company, General Research Laboratory.*

In two base glasses containing sodium oxide 16%, dolomite lime 10% and silica 74% and sodium oxide 14%, dolomite lime 12% and silica 74%, iron oxide was systematically substituted for (a) Na_2O, (b) CaO.MgO, and (c) SiO_2 in amounts of 1, 3 and 5%. The iron was added as ferric oxide and ammonium sulphate was used in the batch as a fining agent being used in amounts sufficient to give 0.2% SO_3 in the glass. The glasses were melted in platinum crucibles in 4.5 lb. melts in a gas fired furnace for a total time of 20 hours at 2600° F. All melts were stirred several times during the melting period.

The resulting glasses were then subjected to various physical tests and the following properties were measured; liquidus temperature, viscosity, deformation temperature, density, fiber softening point, coefficient of expansion, and chemical resistance.

From the data obtained it was shown that the addition of iron increases the density of the glass. When iron oxide is substituted for silica the liquidus temperature is first lowered and then is increased. Its substitution for CaO.MgO first causes no change in liquidus temperature and is then different for the two glasses. When substituted for Na_2O it increases the liquidus temperature. In the case of the coefficient of expansion when iron oxide replaces silica the expansion coefficient is increased, not changed when CaO.MgO is replaced and decreased when Na_2O is replaced. The replacement of SiO_2 by Fe_2O_3 has a variable effect on the deformation temperature causing a lowering in the 10% lime series and no significant change in the 12% lime series. The replacement of CaO.MgO by Fe_2O_3 results in an appreciable lowering of this temperature while the substitution of Fe_2O_3 for Na_2O results in a rapid elevation of the deformation temperature.

The substitution of Fe_2O_3 for SiO_2 decreased the viscosity throughout the range investigated while the substitution for CaO.MgO resulted in an increase in the high temperature viscosity and a decrease in the low temperature viscosity. The substitution of Fe_2O_3 for Na_2O increased the viscosity throughout the given range.

The replacement of SiO_2 by Fe_2O_3 resulted in no change in the resistance of the glass to dilute acid. The replacement of CaO.MgO by Fe_2O_3 was detrimental especially in the 10% lime series while the replacement of Na_2O was beneficial especially in the 10% series. The substitution of Fe_2O_3 was beneficial to the resistance against distilled water for all the glasses made. This substitution being the most beneficial when made for Na_2O and the least when made for CaO.MgO. In the case of SiO_2 this substitution was intermediate in its effect.

Effect of Tin in Gold Ruby Glass. *By F. M. Veazie and W. A. Weyl, Department of Ceramics, Pennsylvania State College.*

Old formulas for gold ruby glass usually call for the use of tin in some form if a satisfactory glass is to be made, it being thought that its reducing action was necessary. As gold ruby glasses are known not to be influenced by reducing or oxidizing agents this specific action of tin in gold ruby has been investigated.

It was concluded that tin exerts strong forces on the noble metals, which determine their solubility behaviour in glasses and decrease their diffusion speed. The tin ion was shown to have a two-fold action; participating in the formation of the glass network and at the same time exerting forces on the metal by its residual valencies, both effects result in a strengthening of the weak bond between the noble elements and the silicate glass.

PRIZE WINNING PICTURES

at the CAMERA CLUB SALON

FRAZIER AWARD WINNER

COLUMBINE
Frazier Award Winner. By F. G. Schwalbe.

OH! SAY CAN YOU SEE!
Industrial: First Prize. By Robt. W. Knauft.

YOU STARTED ME THINKING
Portrait: First Prize. By J. Earl Frazier.

N H_4 CL
Scientific: First Prize. By G. M. Ehlers.

GOAL AHEAD
Industrial: Honorable Mention. By J. Earl Frazier.

BARBARA
Portrait: Honorable Mention. By Robt. W. Knauft.

SECURITY
Trade Paper: First Prize. By Frederick Heath, Jr.

SUNDAY HIKERS
Pictorial: First Prize. By Rolland Roup.

BREAKERS
Pictorial: Honorable Mention. By E. L. Hettinger.

THE BACK DIVE
Action: First Prize. By Rolland Roup.

Red Silver Glasses. *By Edward Frost Jr., and Norbert J. Kreidl, Department of Ceramics, Pennsylvania State College.*

A study of the "striking" properties of certain glasses containing silver revealed that it was possible to develop a red color instead of the usual silver color. Experiments were then conducted to determine the exact conditions necessary for the development of the silver red instead of the well known silver yellow.

It was found that the red color was a result of a precipitation of elemental silver at the interface of the glass and an immiscible chloride. Other halides are also effective. It was concluded that the main field of application of this phenomenon would be in glazes, enamels, and vitrifiable colors in which opacity is acceptable or desirable and where red colors could be produced by the simultaneous use of silver compounds and halides, particularly the bromides.

A Study of Photoluminescence in Glasses. *By A. R. Rodriguez and C. W. Parmelee, Department of Ceramic Engineering, University of Illinois.*

A study of the influence of composition, temperature, and heat treatment on the photoluminescence of two distinct types of luminescent glasses was made and from the behaviour of their spectra it was possible to distinguish clearly between the two types and to obtain information as to the nature of the fluorescing centers.

The first type of photoluminescent glass studied was represented by a uranium glass in which the fluorescing center is due to a coordination group of uranium and oxygen. A correlation appears to exist between the emission of uranium glasses and the radii and number of the secondary cations present in the base glass. In general, the intensity of fluorescence diminishes with decreasing ionic radius and increasing number of secondary ions in the glass structure. This is explained on the basis of the disturbance caused by the undirected electrostatic field of the secondary cations. Slight shifts in the spectrum were also observed in substituting the secondary cations in the silicate glasses, but the general character of the spectrum remained unchanged.

As the base glass is changed the characteristics of the spectrum change completely, the spectrum becoming richer in structure as the change from a borate to a silicate to a phosphate glass is made. The explanation being that more oxygen is brought in as these changes are made and the interfering secondary cations are not increased. The protecting sheath of oxygen around the uranium ion is increased thus enabling it to emit with less disturbance.

While heat treatment does not seem to appreciably alter the fluorescence of uranium glasses, raising the temperature diminishes their fluorescence.

The second type of photoluminescent glass studied was the type represented by copper and which has as its fluorescing centers, copper stones or, probably, very small groups of copper stones. The intensity of fluorescence tends to increase towards higher silica and lime contents. It has, also, a marked phosphorescence which increases with the silica content and diminishes with increasing lime content. The highly phosphorescent glasses are poorly fluorescent and vice versa. In this type of glass the fluorescence-temperature relationship shows a maximum around 86° C.

A Study of Diffusion in Glass. *By J. A. Pask and C. W. Parmelee, Department of Ceramic Engineering, University of Illinois.*

If, as has been proposed, glass is a liquid at high temperatures and a super cooled liquid at temperatures below the softening point laws analogous to those governing diffusion in liquids should also apply to diffusion in glass. In the present work, which is exploratory in nature, a series of fundamental experiments on the nature and rate of diffusion of various compounds into commercial soda-lime-silica glasses have been made.

In the experimental procedure the glass samples were made in the form of small thick-walled cups which could be fitted into Alundum crucibles thus providing a means of support at high temperatures. The various salts under investigation were placed in the glass cup and heated at temperatures up to 900° C. for various lengths of time. The amount of material diffusing into the glass was determined by weighing the glass cup after removing the residue in the cup. The cups were then cut in half vertically, polished and then photographed. The distance of diffusion could then be measured. The colors present were also noted.

Of the various salts tested, those of silver, thallium and vanadium diffused. Copper salts showed a reaction with the glass with a possible diffusion. It was found that the rate of diffusion for silver nitrate at a given temperature is practically constant up to about 10 hours test time after which it falls off. The increase of diffusion for a given time with temperature rise is more rapid. A break is shown at the softening temperature and another is probably present at the temperature of rapid decrease of viscosity. At the softening temperature of the glass there is a sharp change in the concentration of silver from silver nitrate with distance of diffusion.

Fick's law was found to hold for a limited time at the beginning of test period. Consequently, the so-called diffusion constant is not constant throughout the entire test period. The concentration gradient is a straight line approaching the distance axis asymptotically. The size of the particles in the colored bands in the specimens above the softening point therefore do not vary progressively since the number does not vary progressively.

Fiberglas: Some Properties and New Applications. *By F. V. Tooley, Research Laboratories, Owens-Corning Fiberglas Corp.*

Fiberglas may be used wherever electricity is generated, transmitted or used; wherever air is cleaned or conditioned; wherever heat is to be conserved, controlled or excluded, or wherever fabrics are to withstand heat, rot, dampness, decay or chemical attack. At present the electrical industry is the chief user of Fiberglas, in the textile form, it being used as an insulating material where its weight and space offer advantages. In the chemical field the material is being used for filtration cloths, anode bags for electroplating and various other places where a corrosive resistant fabric is needed. In thermal insulation Fiberglas offers low thermal conductivity, fire safety, enduring resistance to vibrations and selling, light weight, cleanliness and durability. Mats of Fiberglas are being extensively used in the manufacture of storage batteries and in the field of air conditioning.

In the national defense program Fiberglas is playing an increasingly important part being used as an effective replacement for cork, non-ferrous ashes, aluminum, and mica and other electrical and thermal insulating materials.

Effect of Chemically Formed Surface Films on Glass Solubility. *By Frank L. Jones and Harold C. Hafner, Bausch & Lomb Optical Co.*

Glass solution involves, in the main, only the loosely held metal atoms with the basic glass forming oxide maintaining its network structure. The chemical durability of a glass was found to improve if it was given a light bleaching followed by baking. In this work several different glasses were given a filming treatment followed by a heat treatment and the change in glass solubility determined.

From the results of these tests it was concluded that the permeability of a leached surface layer on a glass surface can be decreased by the use of suitable methods such as baking and thus will result in an improvement of the durability. While the thickness of the film does not have to be great a thick film is more efficient protection unless the thickness is so great that it pulls away from the base glass. With increased baking temperature the protective effect in-

(*Continued on page* 194)

THE USE OF TOPAZ AS A GLASS OPACIFIER

Thesis under the direction of W. A. Weyl and N. J. Kreidl, Dept. of Ceramics, State College, Penna.

By SAMUEL B. MEYER, JR.

Shortage of Fluorine Opacifiers

The present scarcity of various opacifying agents[1] creates a serious situation to some smaller glass plants specializing in the manufacture of opal glass. The customary opacifiers in this type of glassware are primarily compounds of fluorine such as fluorspar (CaF_2), cryolite ($3NaF.AlF_3$), sodium fluoride (NaF), and sodium silicofluoride ($2NaF.SiF_4$). None of these materials except fluorspar has been freely available in 1941 for various reasons. For example, cryolite is an important raw material for the production of aluminum. Sodium silicofluoride formerly was imported as a comparatively cheap by-product of the European fertilizer industries, importation of which has of course ceased. Its manufacture in this country has increased, but the allocation of such materials will greatly restrict if not prohibit its use for ceramic purposes. Sodium fluoride, which can replace the other opacifiers, is an expensive chemical. It has to be manufactured from hydrofluoric acid which in turn must be liberated from fluorspar by means of sulphuric acid. This process is not only costly but involves chemicals which are subject to priority. Hence limited stocks which existed prior to war regulation have already been exhausted by eager ceramists.

In view of this situation it would seem that fluorspar must be given major consideration as an opacifier. Wherever no specific standard of opacity of opal ware is necessary this may be tolerable to a certain extent. Many plants, accustomed to using substantial additions of cryolite or sodium silicofluoride, will have to be satisfied with fluorspar alone until such time as restrictions on cryolite, silicofluoride, or regular opal cullet are eased. Any quality opal such as the illuminating glassware, however, depends on an additional fluorine opacifier besides fluorspar, because a proper fluorine content must be maintained without attaining an objectionably high percentage of calcium.

It may be feasible to discontinue a certain line of opal glass and to replace it by flint glassware, just as many items of colored glass have been dropped by several manufacturers. But in many small and medium sized plants the production of their particular opal glass is essential to the continuation of their business. Specific experience and skill in this field are now the competitive factors for production which would be lost immediately if competition were to be shifted to the large field of ordinary flint glass.

Other types of opal glass opacifiers, which do not contain any fluorine, have been used in the past and have been described in the literature.[2] But since we are accustomed to the fluorine type of opacification, topaz. a fluorine containing mineral which has not yet been used by the industry, was investigated.

Topaz

The use of topaz as an opacifier was deemed practical due to the recent discovery (1937), in South Carolina, of a large deposit of massive topaz ($Al_2O_3.SiO_2(F,OH)_2$) which contains approximately 13 per cent of fluorine. The iron content of 1 per cent is rather high, but better grades might be available.

Topaz occurs in well-defined crystals and cleavable masses in a surrounding of tourmaline, lepidolite, albite, fluorite, apatite and beryl. It crystallizes in the pyramidal class of the orthorhombic system with a prismatic habit, perfect cleavage in one direction and weak birefringence. White, yellowish, bluish, and reddish colors are encountered, but the pure topaz is colorless. It is characterized by high specific gravity and hardness and until now has been used as a gem stone only. The newly discovered deposit has been described by Pardee, Glass, and Stevens[3] and in 1941 its use for making refractories was suggested.[4] This use is based on the facts that topaz loses most of its water and fluorine between 850° and 900°C. and that mullite is formed at high temperatures. The topaz used in this investigation† was of a pinkish color and analyzed as shown in Table I.

TABLE I

Chemical Analysis of Topaz

	(1)	(2)	(3)
SiO_2	33.00%	32.70%	42.80%
Al_2O_3	56.76	57.80	48.62
Fe_2O_3	trace	0.75	0.98
H_2O-	0.04	not reported	ignition
H_2O+	2.67	not reported	loss: 1.51
F_2	13.23	14.20	11.93
	105.70	105.45	105.84
—O=2F	5.57	5.98	5.03
	100.13	99.47	100.81

(1) Analysis reported by Pardee and associates.
(2) Analysis reported by Stuckey and Amero.
(3) Analysis of material used in this investigation.

Fluorspar-Topaz Opal Glass

This topaz was investigated as a substitute for the calcium-free opacifiers in opal glass such as cryolite, sodium fluoride, or sodium silicofluoride. A base glass of the illuminating ware type was used where the calcium content was rather low. This opal glass had a fluorine content of 7 per cent, while the calcium and aluminum oxide contents were 6.6 per cent and 5.2 per cent, respectively. Due to the high alumina content of topaz, not all of the fluorine of the glass could be introduced by topaz substituting cryolite, because otherwise the alumina content of the resulting glass would be much higher. Thus, if the calcium fluoride content were left unchanged and all the cryolite replaced by topaz without changing the alumina content, the fluorine content of the resulting batch would be only 5.8 per cent instead of 7 per cent. The opacity and the other properties of this opal glass were absolutely the same as those of a usual opal glass of the same fluorine content. Since in this glass there is a deficiency of about 1 per cent fluor-

(*Continued on page* 195)

INVENTIONS AND INVENTORS

A Summary of United States Patents of Interest to the Glass Industry Issued During April

Furnaces

Probably the two most active inventors in the development of electric glass melting furnaces have been John Ferguson of Cleveland and Edouard V. Borel of Romont, Switzerland. Both received patents in March. John Ferguson's latest patent 2,276,295 describes a melting furnace discharge orifice in which the orifice block acts as an electrode to heat the glass flowing through it. This is a modification of a similar device discussed in the March 1940 GLASS INDUSTRY (patent 2,186,718). Borel's two latest patents, 2,277,678 and 2,277,679 are assigned as usual to Societe Anonyme des Manufactures des Glaces & Produits Chimiques de Saint-Gobain, Chauny & Cirey, Paris, France. In the first of these patents Borel extends banks of electrodes up through the hearth of a melting furnace into the glass but leaving room for the glass to flow over and between them on its course to the drawing end. In patent 2,277,679 illustrated by Fig. 1, the electrodes extend horizontally all the way across the furnace as in an earlier Borel patent 2,225,616 (Feb. 1941 GLASS INDUSTRY). At least one of the electrodes is integrally associated with a refractory floater block so that the glass must flow under it. To allow the electrode to be exposed at the glass surface without the protection of the refractory would allow it to be burned away or corroded.

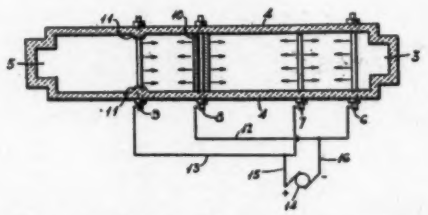


Fig. 1. Borel: 2,277,679. Glass furnace with electrodes 6, 7, 8, and 9 under the glass surface, and with 8 being carried just under a refractory floater block 10. The drawing end of the tank is at the left.

Frederick W. Adams of Pittsburgh and the Pittsburgh Plate Glass Co. received patent 2,274,643 covering a modification of their method of removing gas bubbles from molten glass by supplying abundant gases to serve as a sweeping means. Vents are provided through an elevated section of the hearth over which a shallow flow of glass takes place toward the drawing end. Carbon monoxide is bubbled through the vents in the forward part of this shallow section, and then an oxidizing gas such as air is supplied through other vents to eliminate the brownish discoloration which may be produced by the carbon monoxide.

Fig. 2 shows Alfred W. Dodge's method for using old tank blocks in repairing glass tanks (2,275,010, Hazel-Atlas Glass Co.). The sidewalls and the bottom rims are built up with new blocks; the eroded hearth is left in place, and old blocks of the fused type are laid upon them in a grouting of plastic material containing grog or block fragments of the same heavier-than-glass type.

Feeding, Forming, and Shaping

In patent 2,275,231 Thomas F. Pearson of Pontefract, England, assigned to Crown Cork and Seal Co. his rights to a mechanical device for varying the period and amount of valve openings for blowing glass articles in a multiple mold machine. Each mold has a valve which can be adjusted independently of the other molds, as may be necessary to increase the amount of blow due to the existence of a leak, or for other reasons.

Andrew H. Stewart of Shields, Pa., and Peter Kucera of Allison Park, Pa., have obtained patent 2,274,105 aimed at preventing the distortion of optical surfaces in solid pressed glass articles due to shrinkage as the glass solidifies and cools. The method is applicable to forming a common type of reflector button which may have optical surfaces on both ends. Their invention consists of providing a thin walled section in the mold so that the glass intermediate of the reflector surfaces will receive the least cooling from the mold and will retain low viscosity and yieldability until the critical reflector surfaces have assumed their final desired contours.

A process of making glass sheets of such thinness that they will be highly flexible is described in patent 2,276,615 issued to Clarence W. Hazelett of Greenwich, Conn. He reports that his product has a flexibility equal to that of base materials such as steel, celluloid, wood, cellophane, etc., to which it may be attached. The forming machine, illustrated in Fig. 3, produces the sheets in vertical position. Molten glass 3 is fed through pairs of rolls 5-6 and 18, to form a ribbon which is grasped by fingers 41 and stretched to form a thin sheet, as the chains which carry these fingers diverge in inverted V fashion. These fingers are so guided as to allow them to open and free the sheet at the bottom of the V. Hazelett reports that glass sheet having a thickness of less than 0.015 inch, such as this process produces, can be rolled up on very small diameters without breaking.

Václav Hrdina of Chlum, near Trebon, Czechoslovakia, describes in patent 2,276,399 (filed Dec. 14, 1938) a method of making stemmed glassware by depositing a gather in the mold and performing blowing and suction operations to mold the stem from a portion of the glass delivered to the mold, the blowing and sucking operations being performed while maintaining the delivered glass unseparated from the blow pipe so that the glass can be

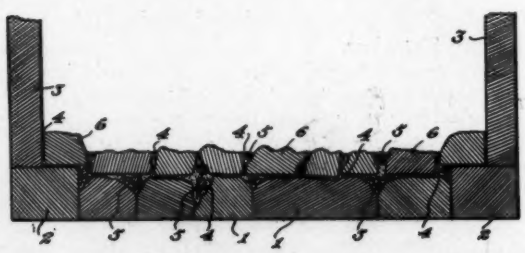


Fig. 2. Dodge: 2,275,010. Tank bottom repaired with old blocks 6 and plastic grogged material, both being of the fused heavier-than-glass type.

worked to its final shape by a further blowing operation. The suction is exerted from the bottom to draw a portion of the glass downward to shape the stem and in some cases even the foot.

Convex surfaces for the ends of cathode ray tubes are shaped in a mold so constructed that the portion which gives this polished surface can be rotated while the remainder of the mold is stationary. This mold is the invention of Max Heim of Berlin-Lankwitz, Germany (2,274,691, Fernseh G.m.b.H. Berlin-Zehlendorf).

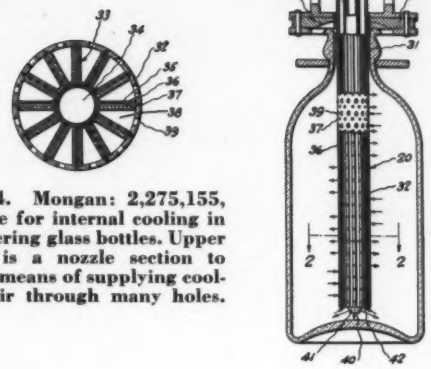


Fig. 4. Mongan: 2,275,155, Nozzle for internal cooling in tempering glass bottles. Upper view is a nozzle section to show means of supplying cooling air through many holes.

Miscellaneous Processes

Glass-to-metal seals are covered by patents 2,274,999 to Victor O. Allen, Madison, N. J. (assigned to Wilbur B. Driver Co.) and 2,276,218 to Hendricus J. Lemmens of Eindhoven, Netherlands. The latter patent was filed June 15, 1940, five weeks after the invasion of the inventor's homeland. The patent is assigned to General Electric Co. The Allen patent introduces a new high chromium alloy, with 1 to 6 per cent of molybdenum, tungsten, or uranium to lower the coefficient of expansion. Lemmens finds that the difficulty of maintaining a seal between quartz glass and large tungsten wires can be overcome if care is taken to obtain a very thin layer of quartz glass relative to the size of the wire.

Fig. 4 illustrates a cooling nozzle used by Chares E. Mongan, Jr., of Hartford, Conn., in patent 2,275,155 (Hartford-Empire Co.) for tempering glass bottles internally. Another new Hartford-Empire patent is Donald G. Merrill's 2,275,263 for methods of controlling the drift of air in lehrs by apparatus which is actuated by temperature change within the lehr.

Daniel P. Gallagher of Harrison, N. J., has patented a process of imparting an inside frost to a glass blub by subjecting the bulb to a solution comprising about 23 per cent hydrofluoric acid, 20 per cent ammonium bifluoride, 4 per cent sodium bicarbonate, 33 per cent denatured alcohol, 10 per cent soda and 10 per cent water. (2,278,257).

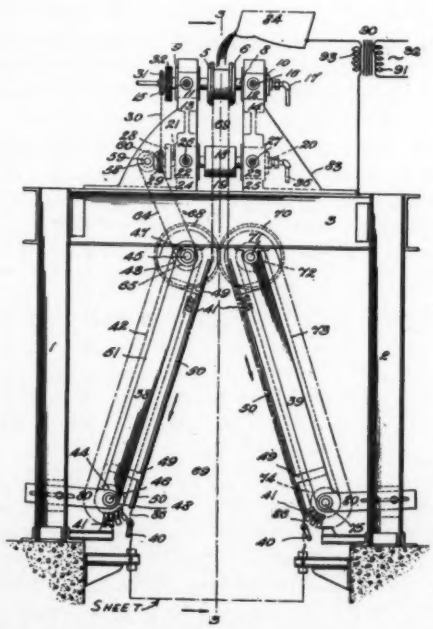


Fig. 3. Hazelett: 2,276,615. Flexible glass sheets less than 0.015 inch thick are made by diverging chains which grasp and stretch a ribbon of glass.

Sheet and Plate Glass

Laminated safety glass is dealt with in Pittsburgh Plate Glass Co. patents issued to Brook J. Dennison of Aspinwall, Pa. (2,274,672), and to Laurence A. Keim of Tarentum, Pa. (2,274,706). The Dennison product is a safety glass containing an interlayer of "polymerized incomplete vinyl acetal resin containing approxmately 32 per cent by weight of tri-ethylene glycol dioctoate as a plasticizer." The Keim product embodys improvements in polarizing sheets which obtain their polarizing power through the alignment of crystals of Herapathite (iodo quinine sulfate). He states that conventional sheets of polarizing material using a cellulose acetate sheet for the crystal-suspending medium become embrittled at low temperatures and have other shortcomings. Keim's process consists of forming a solution of vinyl acetal resin containing polarizing crystals, flowing the solution upon a temperary backing (such as a sheet of cellulose acetate) to form a polarizing film, evaporating the solvents from the film and removing the film from the temporary backing by contacting it with a sheet of vinyl acetal resin to which it is transferred under heat and pressure. The vinyl acetal resin sheet with attached polarizing film may then be applied to glass sheets to form polarizing safety glass.

Other Pittsburgh Plate Glass Company patents were 2,278,369 to Frank W. Hall of Brakenridge, Pa., for a wall construction utilizing laminated glass, 2,274,730 and 2,278,360 to Wm. Owen of Pittsburgh for double glazing construction, 2,278,273 to Don R. Limbers of Clarksburg, W. Va., for a glass cutting apparatus, and 2,274,729 also to Wm. Owen for a platform adapted to support glass plates during silvering.

Pete Magrini of Belle Vernon, Pa. (American Window Glass Co.), has patented (2,278,328) an improvement on his previous methods of reducing batter or waviness in unpolished sheet. In a previous patent 2,246,053 (GLASS INDUSTRY, Aug. 1941) he reported that in a vertical drawing process these defects were evidently the result of air currents striking the glass perpendicular to

the sheet near the meniscus. His solution was to exhaust the air from the drawing chamber and to provide a controlled transverse circulation of air from one edge of the sheet to the other. Now Magrini has found that something more is needed since the sheet tends to bow or warp and consequently to break in passing through the rolls. The step he adds is to blow warm air (85°F) against at least one face of the drawn glass sheet at a point where it has become partially set, and preferably after it has passed through at least a portion of the annealing range (typically, 850°F to 1100°F). The blowing of air directly against the rising sheet at such a time is reported to remove or prevent objectionable warping or bowing. In the Fourcault process the air is directed at the sheet at a 45° angle, and strikes it before the first rolls of the lehr are reached. In most cases satisfactory results are obtained by blowing against only one face, this preferably being the side of the glass on the canal side of the drawing pit.

Patent 2,274,986 granted to George Klian and Robert Strohschneider (Deutsche Tafelglas Aktiengesellschaft, Fürth i. B., Germany) is directed at eliminating stoppage in the Fourcault process due to clogging of the drawing chamber by a progressive accumulation of highly viscous or devitrified glass. They report that the running period can be extended considerably if auxiliary heating is supplied by passing an alternating electric current through the glass bath below the drawing nozzle, in such a way that the electrode tips are located directly under each end of the slot of the drawing nozzle. Fig. 5 will serve to give the general idea.

Max Skolnik of Chicago obtained patent 2,276,108 for a decorated glass plate cushioned from a sorel cement backing body by a layer of solid bituminous material.

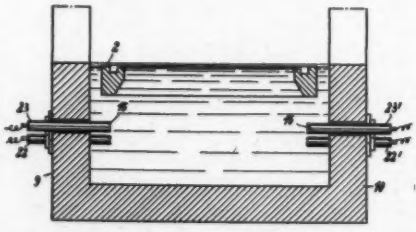


Fig. 5. Kilian: 2,274,986. In the Fourcoult process electrodes placed immediately under the ends of the drawing nozzle prevent congestion due to devitrification and accumulation of viscous glass.

Glass Wool and Fiber

In winding strands or fibers on a spool or tube, Ed Fletcher of Newark, Ohio (Owens-Corning Fiberglas Corp.), reports in patent 2,274,681 that considerable difficulty is experienced due to the fact that as the strand builds up, the tube becomes compressed on the holder with such force that it is difficult to remove. The improvement provided is a centrifugal grip on the holder which releases the tube or spool when rotation ceases.

Gale T. Pearce of Somerville, N. J. (Johns-Manville Corp.) provides in patent 2,278,092 an apparatus for removing the tiny pellets or shot which form in blowing mineral wool. The device merely deflects the shot from the blowing room, while allowing the fibers to fall naturally.

Patent 2,278,207 granted to Kenneth N. Mathes of Schenectady (General Electric Co.) describes spun glass products in which the fibers are coated with a composition consisting of about one part of aluminum stearate and one to two parts of polyisobutylene.

Lieutenant John T. Ogden, Publisher of *The Glass Industry*, now with the American Field Service attached to the British Middle East Armies, is shown with one of his aides in front of the former's quarters "somewhere in India." Gunga Din sitting in the left hand corner.

G.C.A. MEETING—MAY 25-27

The Annual Membership Meeting of the Glass Container Association will be held this year at the Westchester Country Club, Rye., N. Y., on May 25, 26, 27. The Board of Directors and various committees will meet on May 25th. Industry sessions will be held on the two following days.

BULB SUIT INDEFINITELY POSTPONED

The Government's anti-trust suit against a group of twelve bulb manufacturers charged with monopoly of the electric light bulb industry, both domestic and foreign, has been indefinitely postponed by Federal Judge Phillip Forman in Trenton, N. J., the result of a request by the War and Navy departments. Prior to the scheduled date of trial The Westinghouse & Electric Company is reported to have filed a consent decree providing that the company will not insert in contracts any restrictions on sales of bulbs.

A. A. HOUGHTON JR. JOINS AIR FORCE

Arthur A. Houghton, Jr., president and member of the Board of Directors of Steuben Glass, Inc., has resigned his position and will report for duty May 21st as a captain in the United States Air Force. Mr. Houghton became associated with Corning Glass Works in 1929 and was elected president of Steuben Glass, Inc., in 1936.

Mr. Houghton will be succeeded by Robert J. Leavy who has been associated with Corning Glass Works and Steuben Glass for twenty-five years. Mr. Leavy entered the cost office of Corning Glass Works in 1917 and in 1927 was placed in charge of costs for the Steuben Division. Upon incorporation of the Steuben Division and establishment of its retail stores Mr. Leavy has been in charge of manufacturing and sales.

CURRENT STATISTICAL POSITION OF GLASS

During March the glass industry continued at the record rate of activity recorded in the previous two months of the year; production, employment and payrolls maintained exceptionally high levels. According to THE GLASS INDUSTRY'S Production Index output during March was valued at $43,000,000 as compared to $36,000,000 in March 1941. During the first quarter of 1942 production was estimated at $124,000,000 or 22 per cent ahead of last year.

Plate glass production during March totalled 5,564,712 square feet according to the Plate Glass Manufacturers of America. This represented a decrease of 70 per cent below March of last year but about equalled the February 1942 total. During the first quarter of 1942 plate glass output amounted to 20,308,000 square feet or 62 per cent less than last year.

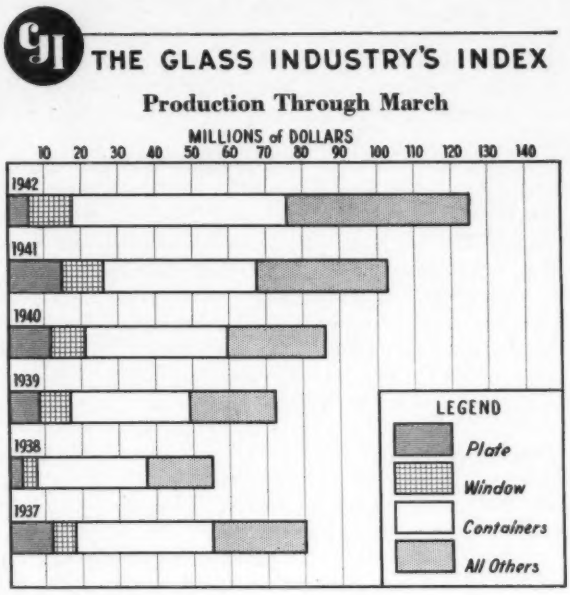
Window glass production during March increased 8 per cent over the February figure to 1,583,046 boxes or 11 per cent more than last year's comparable total. During the first quarter of 1942 window glass output totalled 4,678,500 boxes, breaking all previous first quarter records; last year's first quarter production was 4,375,000 boxes. During March the window glass industry operated at 97.5 per cent of capacity.

Glass container production during March totalled 6,935,284 gross according to the Glass Container Association of America. This was 16 per cent above the February volume and 35 per cent greater than the March 1941 total. During the first quarter of 1942 glass container production totalled 19,655,223 gross, which was 40 per cent above the 1941 level.

Shipments of glass containers during March amounted to 7,064,282 gross. This was 38 per cent more than the March 1941 volume. Increases were reported over last year for all types of containers with greatest gains indicated in domestic fruit jars (up 768 per cent), domestic jelly glasses (up 428 per cent), narrow neck food containers (up 157 per cent), and beer bottles (up 104 per cent). Wide mouth food jars increased 42 per cent, and pressure and non-pressure ware increased 18 per cent, as did liquor ware, medicinal and toilet ware and general purpose ware; milk bottle shipments were 15 per cent greater. Total shipments for the first quarter of 1942 amounted to 19,091,323 gross—a gain of 41 per cent over last year. Here again, domestic fruit jars, jelly glasses, narrow-neck food containers, beer bottles led the industry gains percentage wise.

Stocks of glass containers in the hands of manufacturers at the end of March totalled 9,458,254 gross or 5 per cent less than the March 1941 figure. This was due to declines in beer bottles, narrow-neck food containers, pressure and non-pressure ware and general purpose ware; stocks of wide mouth food jars, milk bottles, liquor ware and medicinal and toilet ware were above the 1941 level.

Miscellaneous glass products manufactured during March were valued at $16,000,000 according to reliable estimates. This compared with $12,000,000 in March 1941. During the first quarter of 1942 this branch of



CURRENT GLASS CONTAINER STATISTICS

(ALL FIGURES ARE IN GROSS)

Types of Ware	*Production*		*Shipments*		*End of Month Stocks*	
	Mar. 1942	*Mar. 1941*	*Mar. 1942*	*Mar. 1941*	*Mar. 1942*	*Mar. 1941*
Food Containers (Narrow neck, wide mouth, and pressed)	1,982,626	1,344,947	2,146,024	1,315,710	2,049,206	2,097,307
Pressure and Non-Pressure	471,848	460,339	503,024	411,652	693,697	1,045,429
Beer Bottles	744,114	406,452	737,239	368,054	344,078	819,220
Liquor Ware	937,984	737,102	983,470	838,345	1,675,911	1,511,291
Medicine and Toilet Ware	1,817,430	1,482,772	1,805,847	1,493,377	3,227,114	3,060,314
General Purpose	553,320	420,281	514,235	435,313	529,632	599,098
Milk Bottles	265,062	213,230	243,144	211,756	392,200	294,040
Fruit and Jelly	135,894	30,396	106,351	12,981	499,094	514,607
All Other	27,006	22,952	24,948	20,152	47,322	37,714
Total Industry	6,935,284	5,118,471	7,064,282	5,107,340	9,458,254	9,979,020

the glass industry had a production of $47,000,000 or 31 per cent more than last year.

Machine-made kitchen, table, and household glassware shipments during March totalled 3,277,798 dozens—3 per cent less than in March 1941. During the 12 months ending March 31, 1942, sales of this ware totalled 39,440,893 dozens, or 18 per cent more than in the previous period.

Machine-made tumbler shipments amounted to 4,482,004 dozens which was 2 per cent above the March 1941 level. This brought the volume for the 12 months ending March 31, 1942 up to 52,814,747 dozens which was 22 per cent greater than in the previous comparable period.

According to a preliminary report of the Bureau of Census, 12 manufacturers of illuminating glassware reported sales during March which totalled $734,000. This represented a 3 per cent increase over February but was 1 per cent under March 1941.

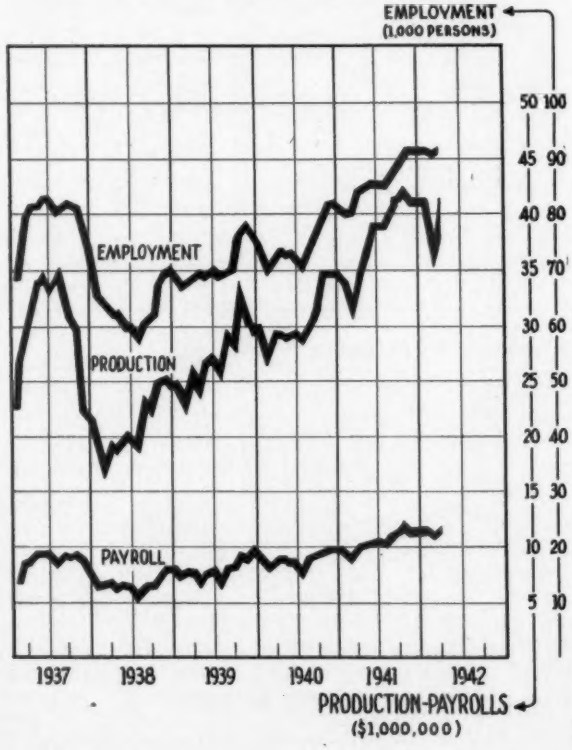
Employment and Payrolls: Employment in the glass industry during March amounted to 92,000 persons, or about equal to the February total. This compared with approximately 84,000 persons during March 1941.

Payrolls in March were estimated at $12,500,000. In March 1941 these payrolls were estimated at a little over $10,000,000.

During the first quarter of 1942 glass manufacturers paid out approximately $36,000,000; last year's comparable figure was $29,000,000.

GI THE GLASS INDUSTRY'S INDEX

Monthly Trends Through March, 1942



CONFERENCE ON THE PHYSICS OF PIGMENTS AND GLASSES

A conference on the Physics and Pigments of Glasses will be held May 15th and 16th at Houston Hall, University of Pennsylvania, Philadelphia, at which technical papers will be presented by seven prominent authors. The conference is being sponsored by the Department of Physics, University of Pennsylvania, and the Philadelphia District Committee, American Society for Testing Materials. Arrangements for the meeting have been made by a joint committee headed by Dr. Frederick Seitz, Department of Physics, University of Pennsylvania. The program follows:

Friday, May 15th—3:00 p.m.

Chairmen: Dr. E. R. Allen, Krebs Pigment Co., Newark, N. J.; Dr. J. T. Littleton, Corning Glass Works, Corning, N. Y.
Introduction: Prof. G. P. Harnwell, Director, Physics Laboratory, University of Pennsylvania.

(1) The Basic Principles Involved in the Preparation of Pigments.
Mr. R. H. Sawyer, Krebs Pigment and Color Corp., Baltimore, Md.

(2) The Basic Principles Involved in the Glassy State.
Prof. B. E. Warren, Massachusetts Institute of Technology, Cambridge, Mass.

Informal dinner in Houston Hall for persons attending the Conference: 6:00 p.m.

Friday, May 15th—8:30 p.m.

Chairmen: Dr. C. Grove, United Pigment and Color Co., Newark, N. J.; Prof. E. C. Bingham, Lafayette College, Easton, Pa.

(3) The Electron Microscope and the Determination of Particle Size.
Dr. R. B. Barnes, American Cyanamid Co., Stamford, Conn.

(4) The Physics of Pigments in Dispersed Systems.
Mr. H. Green, The Interchemical Corp., New York, N. Y.

Saturday, May 16th—10:00 a.m.

Chairmen: Mr. F. C. Flint, Hazel-Atlas Glass Co., Washington, Pa.; Dr. J. E. Bailey, Plax Corp., Hartford Conn.

(5) The Mechanical Properties of Glasses.
Dr. F. W. Preston, The Preston Laboratories, Butler, Pa.

(6) Glass—Pigment Systems.
Dr. C. Robertson, R. & H. Division, E. I. du Pont de Nemours and Co., Perth Amboy, N. J.

(7) Deterioration of Materials by Light.
Dr. F. Seitz, Randal Morgan Laboratory, University of Pennsylvania, Philadelphia.

Further information may be obtained by writing to the Department of Physics, University of Pennsylvania, or A.S.T.M. Headquarters, 260 S. Broad Street, Philadelphia. All concerned with the subjects to be discussed are cordially invited to attend.

CURRENT PRICES OF GLASS-MAKING MATERIALS

FURNISHED BY PRODUCERS, MANUFACTURERS AND DEALERS

Base Materials

		Carlots	Less Carlots
Barium carbonate ($BaCO_3$), Crude, (Witherite) 90%, 99% through 200 mesh	ton	....	....
Precipitated material		55.00	60.00
Barium sulphate, in bags	ton	19.00	24.00
Barium sulphate, glassmaker's, carlots, bulk f. o. b. shipping point	ton	15.00–16.00	18.00
Borax ($Na_2B_4O_7 10H_2O$)			
Granulated	In bulk, ton	42.50	....
Granulated	In bags, ton	46.00	57.00–62.00
Powdered	In bags, ton	51.00	62.00–67.00
Boric acid (H_3BO_3)			
Granulated	In bulk, ton	96.50	
Granulated	In bags, ton	100.00	112.00–117.00
Calcium phosphate ($Ca_3(PO_4)_2$)	lb.	.07	.07½
Cryolite (Na_3AlF_6) Natural Greenland (Kryolith)	lb.	.10–10½	.11
Synthetic (Artificial)	lb.	No supplies available.	
Feldspar—(published list prices)			
20 mesh	ton	11.00–13.25	
40 mesh	ton	11.50–13.75	
Granular	ton	11.75–14.00	
Semi-granular	ton	11.00–13.25	
L. C. L., (Min. 2 tons) $3.00 per ton additional plus charge for bags.			
Fluorspar (CaF_2) domestic, ground, 96–98% (max. SiO_2, 2½%)			
Bulk, carloads, f. o. b. mines	ton	34.00	....
In bags	ton	36.40	50.00
Kryolith (see Cryolite)			
Lead Oxide (Pb_3O_4) (red lead) (N. Y.)	lb.	.0900	....
In 5 Ton lots	lb.	....	.0950
Less than 5 Tons	lb.	....	.10
Lime—			
Hydrated ($Ca(OH)_2$–MgO) (in paper sacks)	ton	8.50	8.50
Burnt (CaO–MgO) ground, in bulk	ton	7.50	....
Burnt, ground, in paper sacks	ton	9.50	9.50
Burnt, ground, in 280 lb. drums	Per drum	2.35	2.35
Kiln Dried ($CaCO_3$–$MgCO_3$) 10x30 mesh	ton	2.00	....
Kiln Dried ($CaCO_3$–$MgCO_3$) 16x20 mesh	ton	2.00	....
Nepheline Syenite, f. o. b. shipping point	ton	13.00	16.50
Potassium carbonate—			
Calcined (K_2CO_3) 96–98%	lb.	.065	.0675
Hydrated 80–85%	lb.	.055	.0575
Salt cake, glassmakers (Na_2SO_4) in bags	ton	21.00–22.00	28.00–30.00
in bulk		17.50	
Soda ash (Na_2CO_3) dense, 58%—			
Bulk	Flat Per 100 lb.	.95	....
In barrels	Per 100 lb.	1.35	....
In Paper bags	Per 100 lb.	1.10	
In Burlap bags	Per 100 lb.	1.15	....
Sodium nitrate ($NaNO_3$)—			
Refined (gran.) in bbls. 95% and 97%	Per 100 lb.	....	3.00–3.40
Bulk	Per 100 lb.	1.35	3.60–4.00
200 lb. bags		1.4675	1.48
100 lb. bags		1.475	1.50

Special Materials

		Carlots	Less Carlots
Aluminum hydrate ($Al(OH)_3$)	lb.	.031–.034	.045
Aluminum oxide (Al_2O_3)		.07	.09
Antimony oxide (Sb_2O_3)	lb.	.15	.15½–.16½
Arsenic trioxide (As_2O_3) (dense white) 99%			
In barrels		.04½	.04¾
Barium nitrate ($Ba(NO_3)_2$)	lb.	....	Open price.
Prophyllite (20% Al_2O_3)	ton	10.00	13.00
Sodium fluosilicate (Na_2SiF_6)	lb.	....	12.50
Tin Oxide (SnO_2) in bbls.	lb.	....	Open price.
Titanium Oxide (ceramic grade) (Priority)			
In bags	lb.	....	....
In barrels	lb.	....	....
Zinc Oxide (ZnO)			
American process, bags	lb.	.07¼	.07½
White Seal, 150 lb. bbls.	lb.	.09¾	.10
Green Seal, bags	lb.	.09	.09¼
Domestic White Seal, bags	lb.	.09½	.09¾
Red Seal, bags	lb.	.08½	.08¾
Zircon			
Refined Granular (Milled .01–.02c higher)		.06½	.07–.08

Coloring Materials

		Carlots	Less Carlots
Barium selenite ($BaSeO_3$)	lb.	....	1.40–1.60
(Commercial, 25% Selenium)	lb.	....	.85
Cadmium sulphide (CdS)	lb.	....	1.10–1.15
Cerium hydrate—			
100 lb. drums and 600 lb. barrels	lb.	....	.60
Chrome Oxide Green, 400 lb. bbls.	lb.	....	.25–.28
Chromite (99% through 200 mesh)	ton	58.25	64.75
Chromite ore (air floated)	ton	58.25	64.75
Cobalt oxide (Co_2O_3)			
In bbls. 350 lbs. or more,	lb.	....	1.84
Less than 350 lbs.,	lb.	....	1.94
Copper oxide—			
Red (Cu_2O)	lb.	....	.20–.22
Black (CuO)	lb.	....	.19–.22½
Black prepared	lb.	....	Open price.
Iron Oxide—			
Red (Fe_2O_3)	lb.	....	.06–.10
Black (Fe_3O_4)	lb.	.04½	.09
Iron Chromate	lb.	....	.035–.05
Lead Chromate ($PbCrO_4$) in bbls.	lb.	....	.16½
Lithium Carbonate	lb.	....	1.25
Manganese, Black Oxide (Caucasian)			
In Paper bags	ton	70.00	78.00
In Burlap bags	ton	71.75	79.75
In Casks	ton	74.00	82.00
Neodymium oxalate, 50 lb. drums	lb.	....	4.00
Nickel oxide (Ni_2O_3), black	lb.	....	.34–.40
Nickel monoxide (NiO), green	lb.	....	.35–.37
Potassium bichromate ($K_2Cr_2O_7$)—			
Crystals and Granular	lb.	.09½	.09¾–.10
Powdered	lb.	....	.10¼–.10½
Potassium Chromate (K_2CrO_4) 100 lb. kegs	lb.	....	.27
Powder blue	lb.	....	.21–.25
Rare earth hydrate—			
100 lb. drums	lb.	....	.35
325 lb. barrels	lb.	....	.30
Selenium (Se) in 100 lb. lots	lb.	....	1.75
In lesser quantities	lb.	....	1.85
Sodium bichromate ($Na_2Cr_2O_7$)	lb.	.07¼	.07½–.07¾
Sodium chromate (Na_2CrO_7) Anhydrous	lb.	.08⅛	.08⅞–.09⅛
Sodium selenite (Na_2SeO_3)	lb.	....	1.50–1.65
Sodium uranate (Na_2UO_4) Orange	lb.	....	1.65
Yellow	lb.	....	1.65
Sulphur (S)—			
Flowers, in bbls.	Per 100 lb.	3.40	3.75–4.15
Flowers, in bags	Per 100 lb.	3.05	3.40–3.80
Flour, heavy, in 250 lb. bags	Per 100 lb.	2.95	3.30–3.70
Uranium oxide (UO_2) (black, 96% U_3O_8)			
100 lb. lots. Black	lb.	....	2.55
Yellow orange	lb.	....	1.65

Polishing Materials

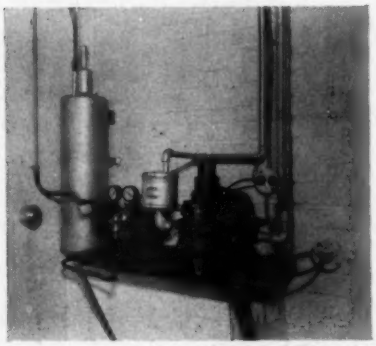
		Carlots	Less Carlots
Emery, Turkish	lb.	.075	.08
Pumice Stone,			
American Ground FFF, FF, F	lb.	.03	.04
0, 0½, ½, 1	lb.	.05¾	.05¾
Putty Powder	lb.	Open price.	
Rotten Stone (Domestic)	lb.	.02¼	.03½
Rouge, Red	lb.	.18	.16
Black	lb.	.15	.18

NEW EQUIPMENT AND SUPPLIES

FIBERGLAS OC-9 BOARD

A material known as Fiberglas OC-9 Board has been developed by Owens-Corning Fiberglas Corporation for blacking out war production plants. Composed of fine, resilient glass fibers compressed and treated with a binder to give it rigidity, the new light-obscuring material is designed to reduce damage from concussion and to provide protection against the spread of fire.

Numerous glass fiber products now installed for air-raid protection also provide a high degree of heat loss reduction and sound absorption. Used as a black-out screen, partition, or as an all-over interior surface treatment, these added qualities effect a saving in fuel costs and aid production because of lessened worker fatigue.



SEALING WITH PREMIXED PROPANE-AIR

A problem of medical glass sealing has recently been solved by Reichel Laboratories, Kimberton, Pa., in the development of a method for sealing dry blood-plasma at a high rate in an evacuated "vipule" (a glass flask stoppered like a vial and sealed like an ampoule).

Reichel Laboratories, out of reach of gas mains, use heavy and relatively slow-burning bottled propane for fuel. Unable to obtain consistently proper glass-working flames under pressure for fast sealing by ordinary fuel-handling means, they installed a type J. Selas Combustion Controller, combining a small positive-displacement compressor and automatic fuel-air proportioning valve (see illustration). This unit reduces the propane to atmospheric pressure and intermixes it, in advance, with all the filtered air required for combustion, in constant ratio. The resultant carbureted fuel is delivered to refractory-tip jets at a constant pressure of about 1½ lbs. per square inch. Evacuated vipules of plasma (after centrifuging, pooling, freezing, and drying in vacuo) are now conveniently sealed at a rate of between 3 and 4 per minute per operator. The vipule rotates on a small brass turntable until the glass has softened to the proper point, at which time the operator manipulates the seal.

AIR-COOLED TRANSFORMERS

For quick and economical conversion of certain plants to all-out-war effort The Acme Electric & Manufacturing Company of Cuba, New York, announce their new line of air-cooled 2400 volt primary transformers. Necessitating only one general wiring system, the transformer is tapped to the power line at a required lighting circuit point. Voltage is reduced and separate metering of the light and power load is eliminated. Almost continuous maintenance of production is possible by the the change-over of the main transformers to a higher voltage and the installation of air-cooled transformers at each feeder circuit.

The new 2400 volt primary Acme Air-Cooled Transformers are available in sizes from 1.5 KVA in single phase design, and 3 KVA to 50 KVA in three phase design. The latter can be had with primaries of 240/480 and 600 volt. 5 per cent taps in sizes from 5 KVA to 50 KVA.

GLASS FIBER FILTER

A short strip of tape, woven of glass fibers, has brought about an important filter improvement in blood plasma transfusion apparatus. Prior to the development of the new glass fiber filter several materials were tried out. Gauze filters proved unsuitable due to swelling when wet; fine wire mesh of stainless steel required a bulky housing. Fiberglas filters, unaffected by moisture, permit free passage of the plasma but effectively block minute particles. They also are sterile and may be resterilized for repeated use.

ELECTROLYTIC CONDUCTIVITY MEASUREMENTS

Because of simplicity, accuracy, speed and moderate cost, the electrolytic conductivity method of measuring and checking is coming into extensive use these days in laboratories, industrial plants and out in the field. This technique applies to the widest range of chemical values, concentration of solutions, the purity of water, the degree of rinse, and other matters. Whenever the electrolytic conductivity of the given item can be correlated with the desired factor such as concentration or moisture content, the conductivity bridge is said to serve as the logical measuring and checking means in providing precise readings at the twist of a knob, thereby eliminating troublesome, time-consuming and often chemical procedure.

According to Industrial Instruments, Inc., Jersey City, N. J., the conductivity bridge built by this organization measures specific resistance of electrolytes from .2 to 2,000,000 ohms. Accuracy of measurements comes within 1 per cent except for extreme ends of calibration, and is entirely independent of line voltage variations. Accurate readings are facilitated by a scale length of about 14 inches, with five ranges or a total of 70 linear inches of calibration.

The conductivity bridge can be used as a standard Wheatstone Bridge for conventional electrical work such as checking carbon and wire-wound resistors, calibrating rheostats and potentiometers, checking leakage, and so on.

CATALOGS RECEIVED

Chas. Taylor Sons Company, Cincinnati, Ohio. Bulletin No. 311, just published by this company, covers the uses of P. B. Sillimite in the metallurgical industries and includes specific information on its applications. Available free by writing to the company.

Wickwire Spencer Steel Co., New York City. An inspiring and patriotic presentation of one company's contributions to industry—past, present and future. Colorful photographs show how Wissco Products are used in military combat.

S. F. Bouser & Co., Inc., Fort Wayne, Indiana. A new booklet illustrating numerous flow indicating devices with full description and purposes to which they are suited.

Clark Tructractor, Battle Creek, Michigan. "Unit Packaging." Interesting in its manner of presentation, this booklet deals with material handling and storage problems, showing step by step those points at which efficiency of production can best be controlled by proper equipment and methods. Package construction is illustrated by photographs of packages possessing distinctive characteristics which could be applied to other materials.

Engineers' Council for Professional Development. 9th Annual Report. A reference report listing accredited undergraduate engineering curricula; reports of standing committees; reports from representatives of constituent organizations; charter and rules of procedure; officers, representatives and committee personnel.

Foxboro Company, Foxboro, Mass. A new bulletin has just been issued, presenting the complete line of Foxboro Potentiometer Temperature Indicators and Indicating Resistance Thermometers. The instruments illustrated and described include single-point and multiple-point models, models equipped with selective key-switches for as many as 82 contact points, as well as portable models. Single range and double range dials are shown in full size reproductions and a complete list of standard ranges is given. Constructional features of the instruments are shown and described.

CARL I. COLLINS
EXECUTIVE VICE PRESIDENT

E. C. Bowers, President of the Wickwire Spencer Steel Company, announces that Carl I. Collins, recently elected to the Board of Directors of the company, has been named Executive Vice President.

A graduate in Mechanical Engineering from the Georgia School of Technology, Mr. Collins entered the steel business with the Atlanta Steel Company. After serving in World War I he joined the Hyatt Roller Bearing Company and in 1923 became plant superintendent and later assistant to the Vice President of the Morris and Bailey Division of the Oliver Iron and Steel Corporation.

Following acquisition of the Oliver company by the American Steel and Wire Company in 1930, Mr. Collins was made general manager of the Morris and Bailey Division and, in 1933, was named general superintendent of the Cuyahoga Works. In 1935 he was made manager of operations of the Worcester district of the American Steel and Wire Company with mills in Worcester, New Haven and Trenton, New Jersey.

FRED C. SAMMONS APPOINTED SALES MANAGER

Refractories Corporation, Los Angeles, Western representative of General Refractories Company, Hartford-Empire Company and Chas. Taylor Sons Company, announces the appointment of Mr. Fred C. Sammons as Sales Manager. Mr. Sammons has been engaged in selling refractories on the West Coast for many years.

S. L. BATES APPOINTED BUFFALO DISTRICT SALES MANAGER

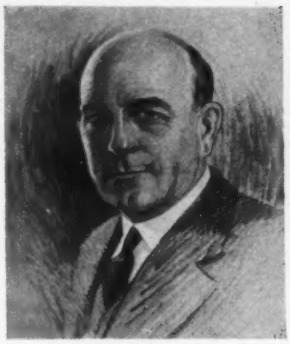
S. L. Bates of Wickwire Spencer Steel Company has been appointed Buffalo District Sales Manager. Mr. Bates, with Wickwire Spencer since 1936 in the Ohio territory, has been associated with the steel industry since 1918.

DEAN E. McCRORY TRANSFERRED TO PHILADELPHIA

Dean E. McCrory, attached to the Pittsburgh office of the heavy chemical sales division of the Pennsylvania Salt Manufacturing Company since 1936, has been transferred to the companyy's executive offices in Philadelphia. He will be concerned with the sales of a number of important products of the company.

• John R. Hostetter has been appointed to the War Production Board as Associate Priority Analyst in the Glass Unit of the Chemicals and Allied Products Branch. Mr. Hostetter, assistant editor of THE GLASS INDUSTRY, left the early part of April to take up his new duties in Washington.

H. B. HIGGINS
EXECUTIVE VICE PRESIDENT



H. B. Higgins, associated with the Pittsburgh Plate Glass Company since 1905, has been elected executive vice president of the Company. Mr. Higgins is a director of the Company and has been a vice president since 1928. He heads the Company's merchandising division and has been active in sales and distribution activities throughout his business career.

In 1912 he became manager of the Kansas City warehouse; in 1917 he was named manager of plate glass sales with his office in Pittsburgh. In 1925 he was appointed general sales manager and three years later became vice president.

S. M. CANTRILL L. R. KESSLER

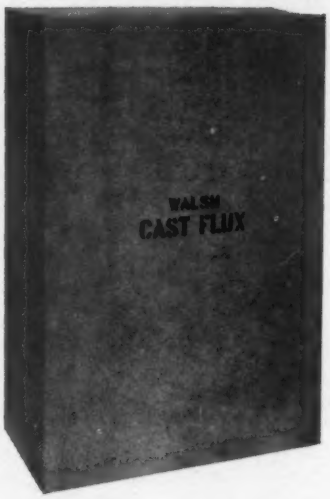
OWENS-ILLINOIS NAMES NEW PLANT MANAGERS

Announcement has been made by the Owens-Illinois Pacific Coast Company of the appointment of L. R. Kessler as plant manager of their Oakland factory and of S. M. Cantrill as plant manager at Los Angeles. Mr. Kessler, formerly Eastern Factories Manager of the Glass Container Division in Toledo, has served in the same capacity in the company's Columbus, Ohio, and Huntington, W. Va., factories. Mr. Cantrill, in returning to Los Angeles as plant manager, is assuming duties which he left a year ago when he was transferred to Oakland.

R. H. Mulford, Los Angeles plant manager for the past year, is returning to the company's general offices in San Francisco to assume a new post created for the correlation of existing manufacturing facilities.

FOR SALE OR LEASE: Small glass factory with new ½ ton tank ready for use in South Jersey. Write Box 51, The Glass Industry, 55 West 42nd Street, New York City.

WALSH CAST-FLUX



The Vacuum-cast flux block of superior quality.

Walsh Cast-Flux blocks are machine-trued to exact size and shape after burning.

THEY LAST LONGER

The excellent results obtained in numerous tanks melting various types of glass has definitely established the efficiency and economy of Walsh Cast-Flux blocks.

Walsh Cast-Flux has a dense, uniform structure; it is burned at higher temperatures, is thoroughly bonded and possesses a low coefficient of expansion.

Walsh Cast-Flux blocks meet the most rigid requirements for tanks operating at higher temperatures . . . they insure greater tonnage, higher quality glass, freedom from defects, longer life and maximum economy.

WALSH REFRACTORIES CORPORATION

Manufacturers of Refractories for the glass industry for over 50 years

4428 North First Street

St. Louis Missouri

ANNUAL MEETING OF THE CERAMIC SOCIETY

(*Continued from page* 184)

creases if however the baking temperature is too high diffusion may take place and the resistance thereby lowered. In general the baking temperature to produce the desired effect is higher for glasses containing larger proportions of network forming oxides such as silica and aluminum and lower for glasses containing more soluble oxides.

Studies Correlating Bottling Line with Pressure—Test Breakage. *By A. Herman and H. M. Kindsvater, Joseph E. Seagram & Sons, Inc.*

Due to the fact that there has been no published information on the relationship between the tensile strength of a bottle and its performance on a high-speed production line the present study was made to determine what correlation exists between production-line breakage and pressure-test breakage.

The Preston machine modified so that an initial pressure of 25 p.s.i. could be obtained was used in the laboratory tests. Quarts, fifths, pints and half-pints collected at regular intervals during the time the production line breakage was being recorded were tested on this machine using the standard A.S.T.M. methods. The results obtained on both the production line breakage and the laboratory test breakage were treated by statistical methods.

It was found that the correlations between production and test breakage percents for the quarts and pints data were significant, that for the fifths data, although slightly significant was definitely positive. The half-pint data yielded no significant relationship between the two breakage percents, but it was believed that this was the result of abnormal bottling line conditions.

A method of determining the range of production breakage percents from the test breakage by use of the standard error of estimate was also described.

Instrumentation and Control of Glass Tanks. *By John R. Green, Brown Instrument Co.*

The various control and instrument equipment that is being or can be used in the control of glass furnaces were discussed. Temperature measurements, automatic control of fuel input, furnace pressure, control of fuel flow, checker balance, and combustion condition control were covered and the necessary equipment was described.

In the case of temperature measurements it was pointed out that noble metal thermo-couples should be protected from contaminating gases by the use of multiple gas-tight protection tubes in addition to the use of crown blocks which have duplicate wells and which can be used for checking purposes. It was shown that radiation units sighted on closed-end refractory tubes, thus removing the element proper from the high temperature zone would eliminate the use of the noble metals and would give readings which change only as the wall thickness or the relative position of the refractory target changes throughout the furnace life. A suggested method of temperature measurement in those cases where the flame travel is kept close to the batch and away from the crown consisted of an externally mounted and open ended radiation tube sighted through the end walls onto the crown's inner face, over a large area and extending the length of the melting or working zone.

Automatic control of the fuel input by the tank temperature has met with little success due to the fact that there is too much lag or delay in the temperature pick-up device or if the above are to be corrected the response is too fast. Accordingly the automatic control over-corrects or under-corrects.

Glass temperatures have been measured by extending noble metal couples through the side or bottom blocks and special water cooled constructions have been used for measuring the temperature of glass at various depths in the furnace.

It was also pointed out that pressure measurements should be of the differential measurement type and that this meas-

urement was important as it had a direct influence on the velocity of the gases, the shape of the flame, the location of the flame over the glass and batch surface and other conditions.

Automatic methods of fuel flow and checker temperature were also described using the methods as practiced in the steel industry as examples.

The Parachor of Inorganic Liquids at High Temperatures. *By Kuan-Han Sun and Alexander Silverman, Department of Chemistry, University of Pittsburgh.*

In many physical chemistry textbooks the equation $\frac{M}{D} \cdot \sqrt[4]{\tau} = P$ is given, where τ = the surface tension, D = the density of the liquid, M = the molecular weight, and P = a constant known as the parachor. The parachor being a measure of the molecular volume at temperatures at which different liquids have the same surface tension.

In this work a study has been made of surface tension and density data for inorganic liquids at high temperatures and new atomic or ionic parachors have been developed for a number of the elements. These new values not only hold better agreement with the experimental data but also bear a close relationship to ionic radii.

The practical application of the parachor lies in the fact that it is possible to predict the surface-tension value of slags and glasses at high temperatures and also enables a better understanding of their structure to be made.

THE USE OF TOPAZ AS A GLASS OPACIFIER

(*Continued from page* 185)

ine with a corresponding lack of opacity, I suggest the following methods which have been found to develop a satisfactory fluorspar topaz opal glass:

(1) If some silicofluoride is still available, the deficiency of 1 per cent fluorine can be easily compensated by the use of a small amount of this alumina free fluorine compound. In this case about 60 per cent of the silicofluoride can be saved by the use of topaz. Also, mixtures of cryolite and topaz can be used; here, however, the saving is not as great as in the case of silicofluoride.

(2) In certain cases the manufacturing methods could be adapted to a glass with a lower fluorine content, bringing out the desirable opacity by changing the heat treatment during or after shaping. In many normal shaping processes, optimum opacity is not attained, but can be developed by this additonal heat treatment (striking).

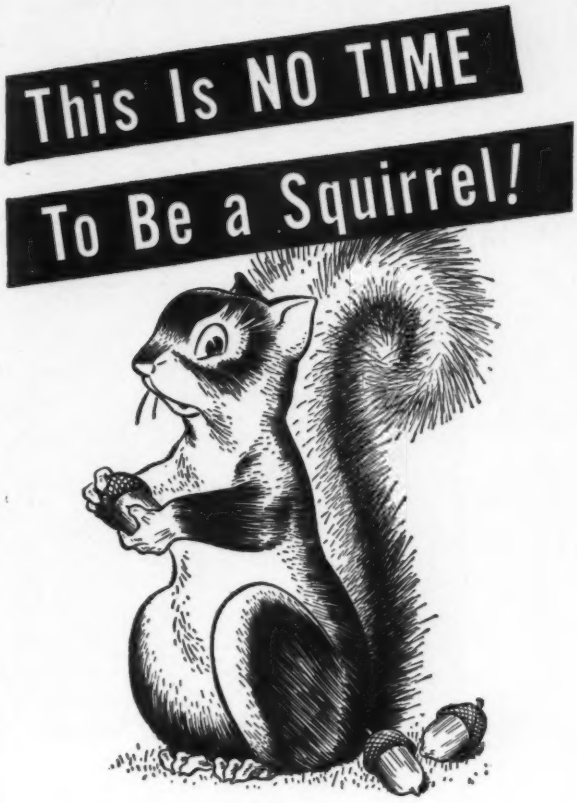
(3) Without increasing the fluorine content or changing the heat treatment of the topaz opal glass, the opacity can be increased by the following changes in the base glass.

(a) Adding small amounts of B_2O_3 is particularly beneficial, especially if this change is made at the expense of the alkali.

(b) Illuminating glasses often contain lead. Replacing it by lime also had been found to increase opacity.

These changes of the base glass were made with the aim of decreasing the solubility of the fluorides which cause opacification.

(4) If we introduce sufficient amounts of topaz to obtain the desirable fluorine content the glass becomes too high in alumina. Such a glass can be made workable by replacing a part of the silica by lime. The resulting glass is low in silica, high in alumina and lime, but the alumina content prevents devitrification and the lime decreases the viscosity. Thus, the defects of high alumina are compensated by the high lime and vice versa. Obviously, the



Squirrels, you know, are always hiding away more food in the ground than they can possibly use.... But for some reason, there always seems to be enough food around to save them the trouble of digging most of it up.

Probably some companies, unintentionally of course, are playing "squirrel"... by tucking away supplies of alkalies "just in case something happens...."

This is an excellent way to help make that "something" happen *right here at home!* If you build up alkali inventories beyond normal requirements, you are taxing production facilities, and preventing delivery of vitally important basic war materials that are urgently needed *now* for the production of ammunition, guns, airplanes, clothing and hundreds of other war necessities.

There is actually no necessity for "stocking up" on alkalies. The raw materials for making alkalies are abundant in America. There are many giant plants now manufacturing tremendous quantities of the finished product. Obviously, war needs come first, which may necessitate sacrifices on the part of companies not producing war materials. In general, however, there are enough alkalies to go around *if none of us plays squirrel.*

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additional lime should be introduced as fluorspar. Table II gives examples of the suggested topaz opal glasses.

TABLE II

1 Cryolite Glass	2 Topaz Glass with unchanged Al_2O_3 and lower Fluorine	3 Same as 2 but fluorine of glass 1 provided by silicofluoride	4 Like 2 but opacity increased with B_2O_3	5 Glass with high CaO and high Al_2O_3
SiO_2	62.21	62.21	62.21	62.21	60.85
Na_2O	10.76	14.4	13.18	8.4	15.45
K_2O	2.67	.25	.25	.25	.25
CaO	6.62	6.62	6.62	6.62	9.07
F	7.	5.78	7.	5.78	6.97
Al_2O_3	5.24	5.24	5.24	5.24	7.00
B_2O_3	2.	2.	2.	8.	—
PbO	2.5	2.5	2.5	2.5	—
ZnO	.5	.5	.5	.5	—
BaO	.5	.5	.5	.5	.29
Batch Composition					
Sand	47.65	57.59	56.59	57.59	54.69
Soda Ash	12.25	23.07	19.85	8.27	26.39
Feldspar	22.05	—	—	—	—
Fluorspar	9.24	9.24	9.24	9.24	10.77
Topaz	—	10.77	10.77	10.77	14.1
Cryolite	4.61	—	—	—	—
Sodium silico-fluoride	—	—	2.01	—	—
Sodium Borate	2.89	2.89	2.89	8.7	—
Litharge	2.5	2.5	2.5	2.5	—
Zinc Oxide	.5	.5	.5	.5	—
Barium Carbonate	.65	.65	.65	.65	.37
Nitre	.54	.54	.54	.54	.54
Arsenic	.25	.25	.25	.25	.2
Lime	—	—	—	—	2.32

The use of relatively large amounts of topaz in the glass tank might lead to certain defects due to the nature of topaz and its tendency to form mullite, which is known to dissolve only very slowly. Wherever this should be the case, a product could be manufactured from topaz by sintering it with sodium carbonate or sodium silicate. This product would resemble a mixture of nepheline with cryoline or sodium silicofluoride. Due to the high iron content of the topaz, these opal glasses exhibit greenish tints which can be partly checked by arsenic and niter.

Summary

The possibilities of using topaz as a raw material for fluorine opal glasses have been described. Changes in batch composition are suggested which permit making a dense opal without the use of opacifiers other than topaz and fluorspar.

[1]"The Glass Making Situation," The Glass Industry, **22** 387 (1941).
[2](a) N. J. Kreidl and W. A. Weyl, Opal Glass, The Glass Industry. February, 1940.
(b) W. A. Weyl, Phosphates in Ceramic Ware I, in Opal Glass Journ., Amer. Ceram. Soc. **24** (1941), 221-25.
[3]J. T. Pardee, J. J. Glass, and R. E. Stevens, "Massive Low-Fluorine Topaz from Brewer Mine South Carolina," Amer. Mineralogist. 22 (1937) 1058.
[4]J. L. Stuckey and J. J. Amero "Physical Properties of Massive Topaz," Journ. Amer. Ceram. Soc., **24** 89 (1941).
†Courtesy of United Feldspar Minerals Corporation.

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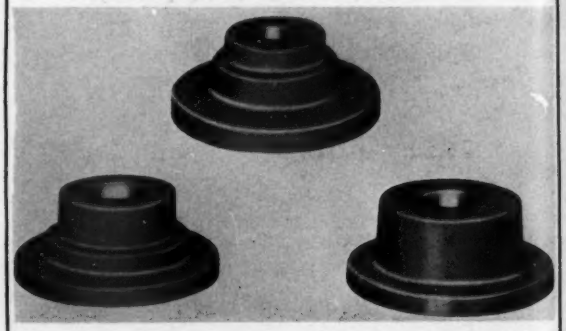

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